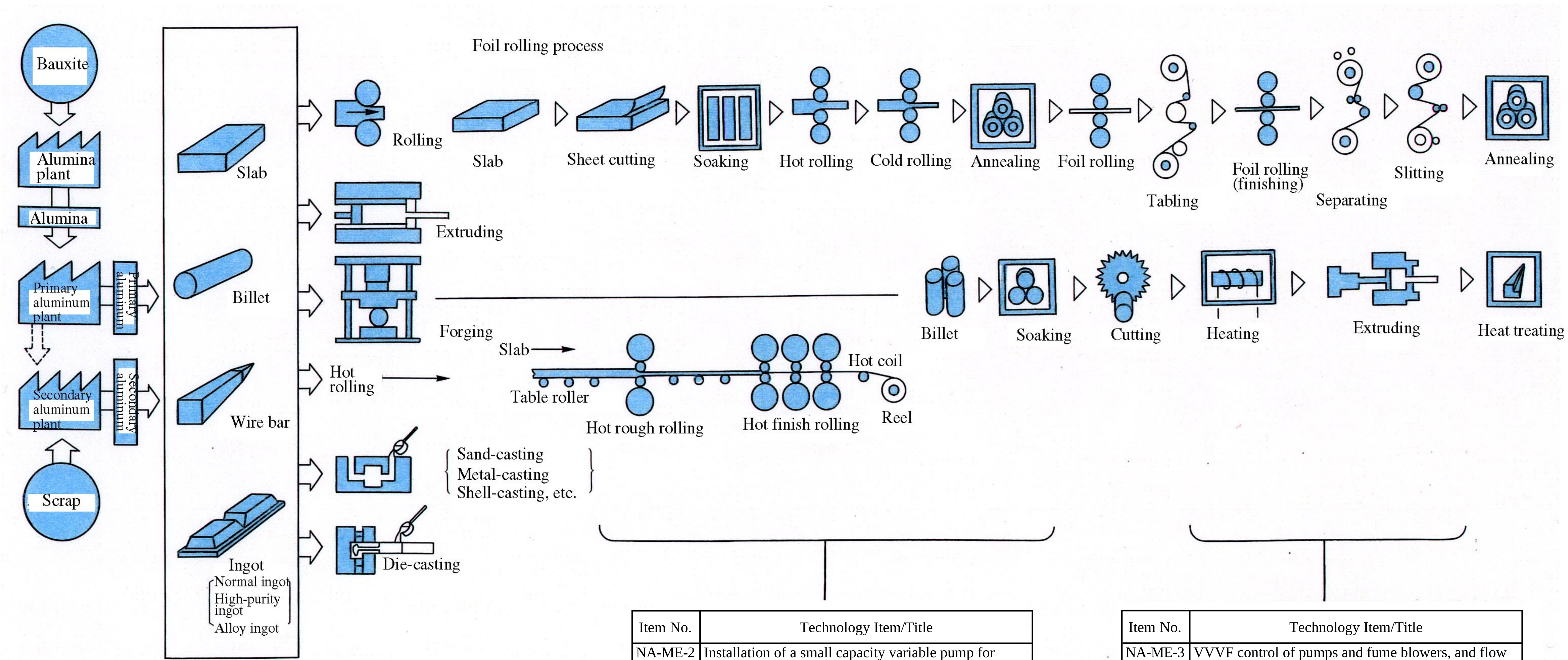
Section 2
Non-ferrous Metal Industry

Process Flow
2-1 Aluminum

2-1 Copper

Non-ferrous (Aluminum) : Production Process and Energy Saving Technology

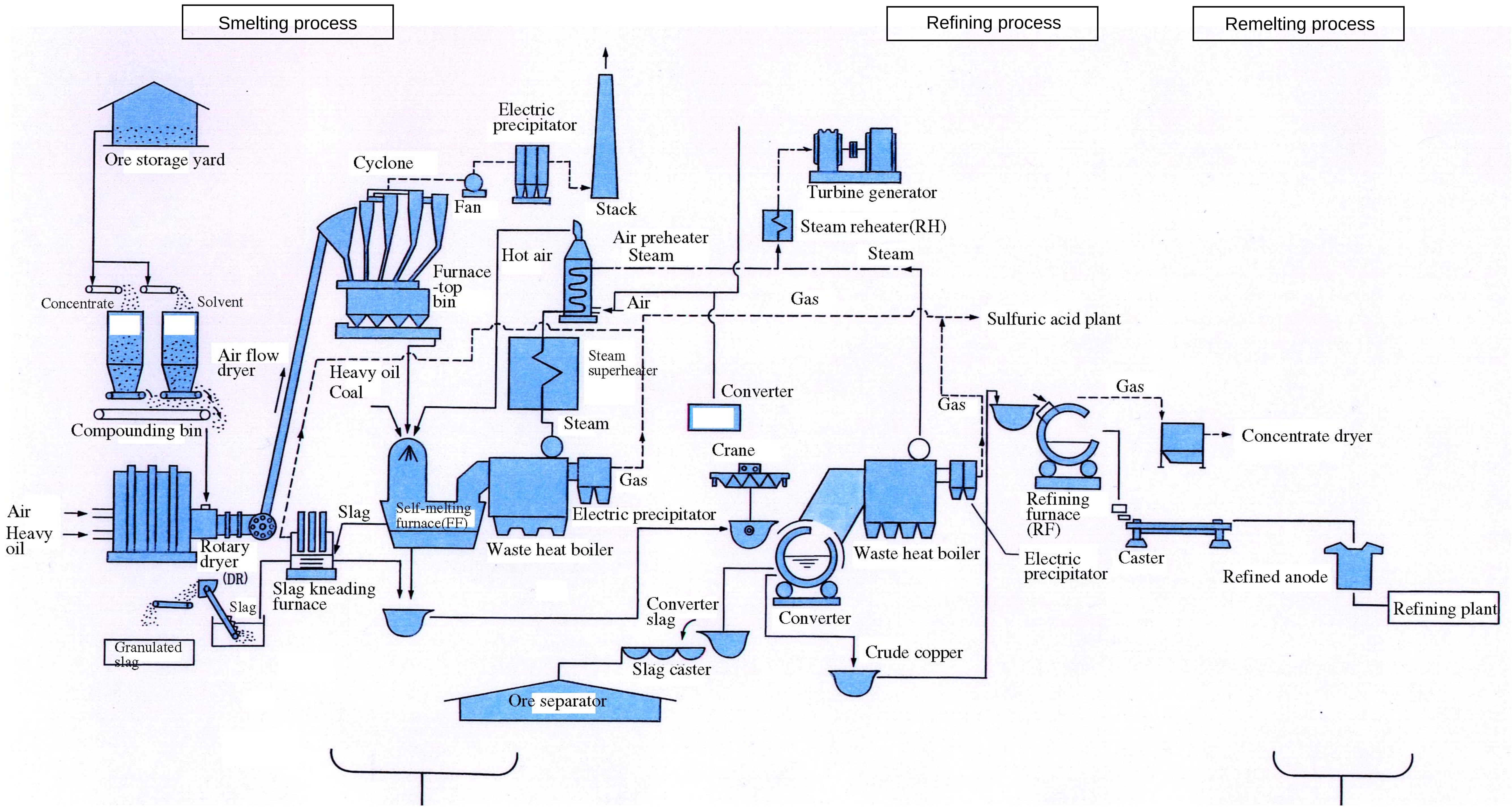


Item No.	Technology Item/Title
NA-ME-1	Immersion melting plating furnace
NA-ME-4	Improvement of thermal efficiency for rapid aluminum melting furnace
NA-ME-5	Regenerative burner type aluminum melting furnace
NA-OM-2	Heat loss improvement of energy saving type electric holding furnace
MI-OM-8	Improvement of efficiency of melting process by continuous desulfurization

Item No.	Technology Item/Title
NA-ME-2	Installation of a small capacity variable pump for keeping hydraulic pressure

Item No.	Technology Item/Title
NA-ME-3	VVVF control of pumps and fume blowers, and flow rate reduction of by-pass circuit
NA-OM-1	Operation method by reduced number of revolutions of circulating fan
NA-OM-3	Improvement of operation of hot air circulation fan for aluminum annealing furnace

Non-ferrous (Copper) : Production Process and Energy Saving Technology



Item No.	Technology Item/Title
NC-ME-1	Efficiency improvement in autogenous furnace in copper smelting process

NC-OM-1	Energy saving in copper electrolysis process

Item No.	Technology Item/Title
NC-ME-2	Waste heat recovery of copper smelting shaft furnace using heat pipes

Data Sheets

2-1 Aluminum

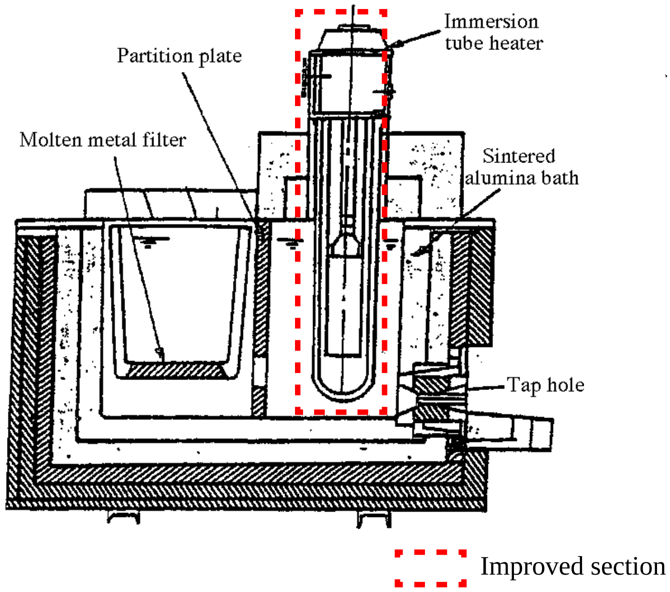
2-1 Copper

NA-ME-1	Energy Conservation Directory	
[Industry Classification] Non-ferrous: Aluminum [Technology Classification] Machinery & Equipment	Immersion melting plating furnace	[Energy Source] Heavy-oil and Gas [Practical Use]

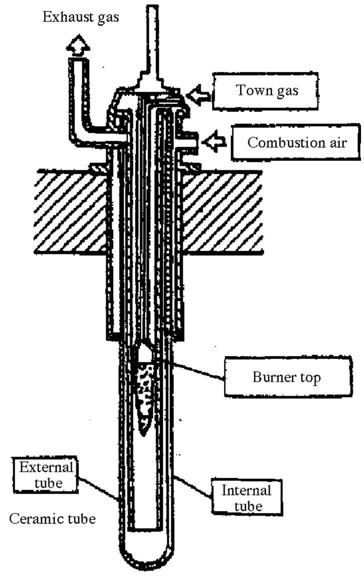
Outline	A furnace which heats, melts, and hold non-ferrous metals such as metal zinc, tin, and aluminum by immersing a combustion-heating tube.
Principle & Mechanism	A conventional furnace indirectly heat the metal in a vessel made of steel from outside through the vessel bottom or side wall. An immersion melting furnace is an energy-saving-type furnace which heats directly the metal with a combustion-heating immersion tube. The furnace has a combustion-heating immersion tube integrated with a special gas burner made of ceramic, a temperature sensor, and specially-designed furnace-temperature control device.

[Description]

Structure explanation, Shape and/or System diagram



Gas-firing aluminum melting and holding furnace



Gas-firing immersion heater

	Heavy-oil-firing iron-ladle furnace	Gas-firing immersion furnace	Reduction rate (%)
Specific melting energy consumption (kcal/kg)	2,500	700	72
Specific holding energy consumption (Kcal/h)	62,000	22,000	65
Variation of molten metal temperature during melting (˚ C)	-25 to +25	-5 to -5	80

Energy saving effect	Melting energy consumption is reduced from 7.76 yen/kg to 2.55 yen/kg. Holding energy is reduced from 216.7 yen/h to 80 yen/h. The annual cost reduction is 4,550 thousand yen assuming the production rate of 65 kg/h, daily operation of 8 h, annual operation of 200 days, and holding time of 2 h/day.
[Economy] Equipment cost	Investment amount: 5 million yen Improvement effect: 200 million yen/year Investment payback: 2 - 3 years
Remarks	Heavy-oil 9300 kcaL/kg, Gravity 0.9 kg/L 26 yen/L 13A 11000 kcaL/m³ 40 yen/m²

[Example sites]	[References]	[Inquiry]
Tanaka Seiko Co. Ltd. Uji Plant		NEDO / ECCJ (JIEC)

NA-ME-2

Energy Conservation Directory

[Industry Classification] Non-ferrous: Aluminum	Installation of a small capacity variable pump for keeping hydraulic pressure	[Energy Source] Electricity
[Technology Classification] Machinery & Equipment		[Practical Use] 1980

Outline	Even when pressure oil was not needed for the pressure-oil system, the main pump of the hydraulic unit was operated in order to compensate leaks. Instead, a small-capacity pump is installed to compensate leaks.
Principle & Mechanism	A small-capacity variable pump to compensate leaks is installed in parallel with the main pump. When pressure oil is not needed for the pressure-oil system, the main pump is stopped and only the small-capacity variable pump is operated to compensates leaks. Instead, a small-capacity pump is installed to compensate leaks.

[Description]

Structure explanation, Shape and/or System diagram

Before Improvement

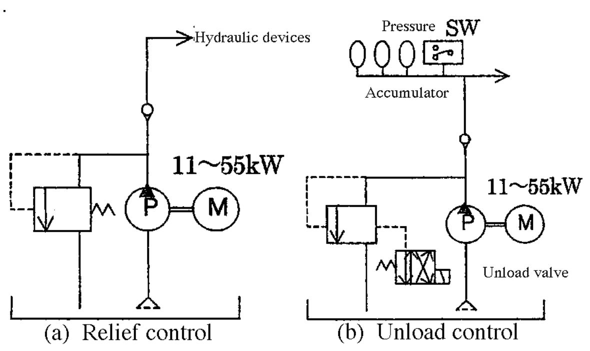


Fig. 1

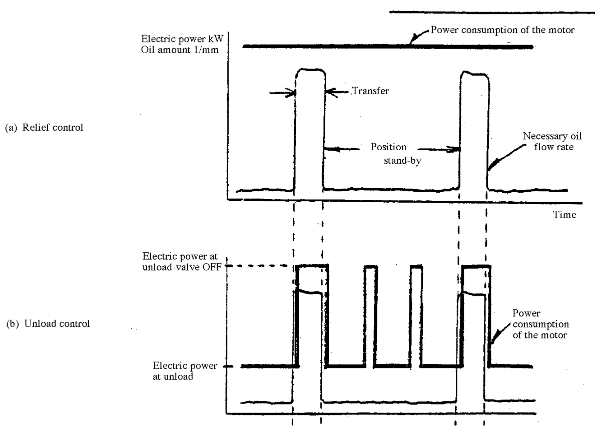


Fig. 3

After Improvement

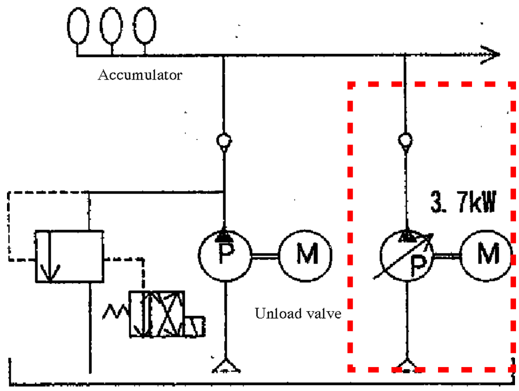


Fig. 2

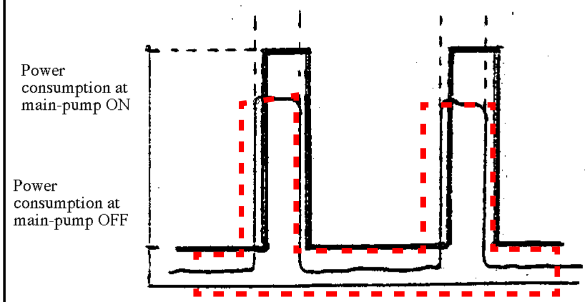


Fig. 4

Improved section

Energy saving effect	The main pump operation requires 11 kW of electric power at minimum. In contrast, the small-capacity pump operation requires only 3.7 kW.
[Economy] Equipment cost	Investment amount: 50 - 60 million yen Improvement effect: 60 million yen/year Investment payback: 1 year
Remarks	

[Example sites]	[References]	[Inquiry]
		NEDO / ECCJ (JIEC)

NA-ME-3

Energy Conservation Directory

[Industry Classification]	VVVF control of pumps and fume blowers, and flow rate reduction of by-pass circuit	[Energy Source]
Non-ferrous: Aluminum		Electricity
[Technology Classification]		[Practical Use]
Machinery & Equipment		1981

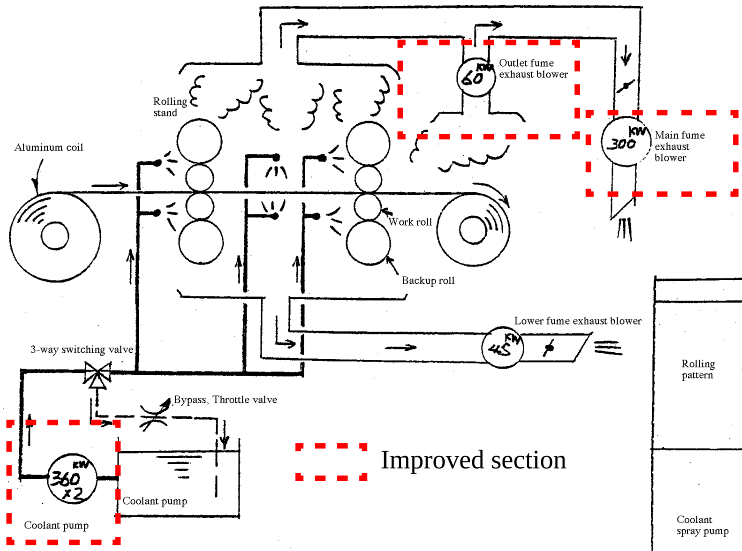
Outline

In a rolling schedule, the time ratio between the rolling operation and the set-up operation is 3:2.
The conventional method was as follows;
1) Coolant pumps and fume blowers were operated continuously.
2) During the set-up, output of the coolant pumps was returned to the coolant tank through the bypass by switching the 3-way valve. However, power consumption in the set-up time was greater than that in the rolling operation.

The following measures were taken:
1) The numbers of revolutions of the coolant pumps and fume blowers are controlled in accordance with the rolling schedule by introducing the VVVF apparatus.
2) Power consumption by the coolant pumps during the set-up time is reduced by throttling the valve of the bypass circuit to the coolant pumps.

[Description]

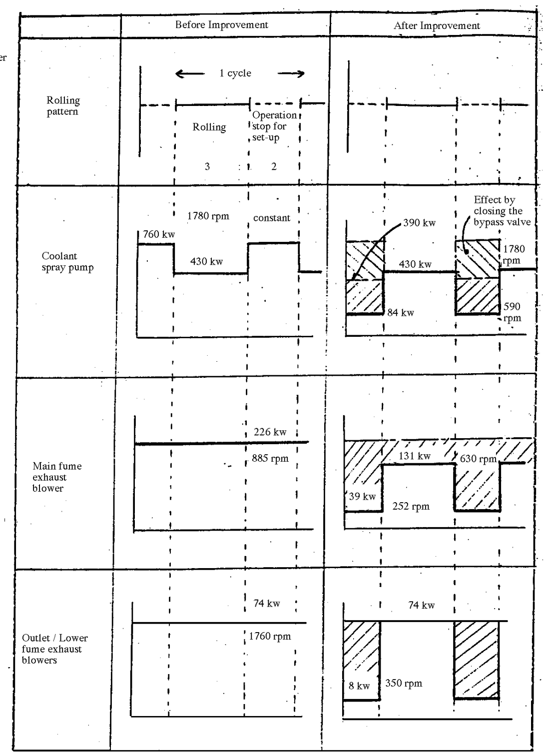
Structure explanation, Shape and/or System diagram



Coolant pump: A pump for spraying coolant oil during aluminum rolling for the purpose of lubricating and cooling, etc. of the surface of the plate.

Fume exhaust blower: A blower for exhausting fume which fills the surroundings when coolant is sprayed.

3-way switching valve: A valve which switches coolant flow and returns it to the coolant tank through the by-pass during the non-rolling time such as coil handling.



Energy saving effect

1) Reduction of power consumption by VVVF control: 2,098,000 kW/year
2) Reduction of power consumption by throttling the bypass valve: 1,118,000 kW/year

[Economy] Equipment cost

Investment amount: 80 - 90 million yen
Improvement effect: 50 - 60 million yen/year
Investment payback: 1.5 - 2 years

Remarks

[Example sites]	[References]	[Inquiry]
Sumitomo Light Metal Industries, Ltd.	In-house Material of Sumitomo Light Metal Industries, Ltd.	NEDO / ECCJ (JIEC)

NA-ME-4

Energy Conservation Directory

[Industry Classification] Non-ferrous: Aluminum	Improvement of thermal efficiency for rapid aluminum melting furnace	[Energy Source] Fuel
[Technology Classification] Machinery & Equipment		[Practical Use] 1984~

Outline

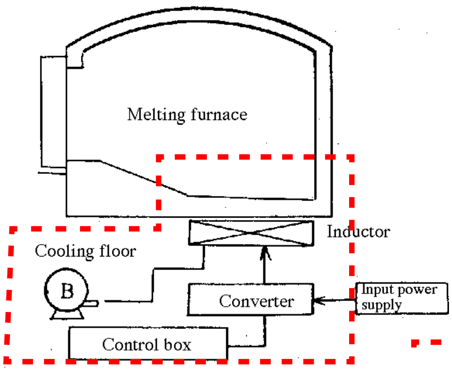
Introduced in this article are various kinds of examples concerned with improvements of thermal efficiency of the melting furnace used for melting aluminum ingot and return materials. Approximately 30% reduction of unit requirement of energy has been achieved through such measures as mixing of molten metal, and burner combustion control through controlling the molten metal temperature and furnace pressure, as well as installation of the recuperator.

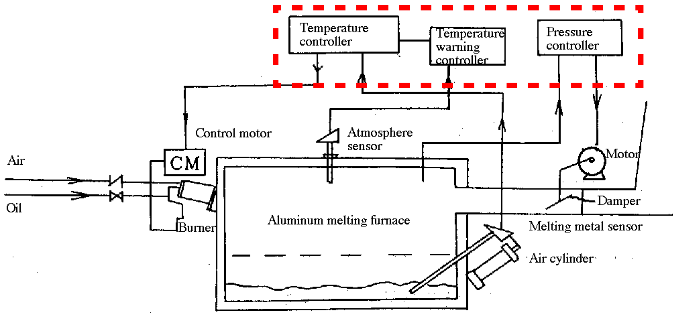
Principle & Mechanism

1) In general, there is a temperature difference of 40 - 60 ˚C between the temperature of the melting metal at the upper part in the melting furnace and that at the lower part; due to this reason, appropriate combustion control was not possible so far by the temperature control of the melting metal.
2) Although recovery of waste gas from the furnace was conducted by the exhaust heat boiler, waste heat recovery could not be made sufficiently, being affected by the load in accordance with the utilization of the steam.

[Description] Structure explanation, Shape and/or System diagram

1) Introduction of electromagnetic induction type mixing machine (Refer to Figure 1.)
Temperature difference between the upper and lower parts of the melting metal has been settled by embedding an inductor on the bottom of the furnace, and setting a mixing machine which is an application of the electromagnetic induction of the linear motor. At the same time, time required for melting aluminum materials has been reduced by approximately 6 %.
2) Introduction of a controller for melting metal temperature and furnace temperature (Refer to Figure 2).
Through controlling the combustion burner by the temperature of the melting metal and damper control by the furnace pressure, approximately 10% of unit requirement of fuel has been achieved.
3) Recovery of exhaust heat by the recuperator
Recovery of exhaust heat being as high as 900 ˚C was made by the exhaust heat boiler previously, but as it was much affected by the load depending on the use of steam, it has been changed, and improved, to heat recovery by using the recuperator.
4) Setting of a tilting type high-speed burner
Because of the capability of freely changing the direction of the flame, the flame can be targeted intensively at any area of unmelted metal, thereby reducing the time required for melting metal by approximately 20%.





Improved section

Fig. 1 Outline of the electromagnetic induction type mixing machine for melting metal

Fig. 2 Flow diagram of controlling melting furnace temperature and furnace pressure

Energy saving effect

As regards the effect of energy saving, 26 L/t of unit requirement of heavy oil A has been achieved in comparison with the consumption before the improvement. It is equal to 184 kL/year when converted into the consumption of crude oil.

Table 1 Effect of energy saving and reduction of metal loss

	Conventional iron melting furnace	After improvement (immersion type holding furnace	Effect
Energy unit requirement	50 kcal/kg (100%)	22 kcal/kg (44%)	27 kcal/kg
Yield (metal loss)	7 kg/T (100%)	2 kg/t (29%)	5 kg/T

[Economy] Equipment cost

Investment amount: 60 million yen
Improvement effect: 40 million yen/year
Investment payback: 1.5 years

Remarks

[Example sites]	[References]	[Inquiry]
Similar improvement cases exist.	"Collection of Energy Conservation Cases 1985," p.1,351	NEDO / ECCJ (JIEC)

NA-ME-5	Energy Conservation Directory	
[Industry Classification] Non-ferrous: Aluminum	Regenerative burner type aluminum melting furnace	[Energy Source] Fuel
[Technology Classification] Machinery & Equipment		[Practical Use] around 1995

Outline

This improvement is to use a highly efficient furnace for melting aluminum, which employs oil or gas firing regerative burners and reduces the specific fuel consumption by more than 30% compared with a conventional melting furnace.

Principle & Mechanism

1) The regerative burner is of a high-speed jet (high-momentum) type which incorporates both 2-step combustion and combustion gas self circulation.
2) The principle of the regerative burner is that it has a regenerative (heat-storing) section in it, and the furnace gas and the combustion air flow through it alternately in a cycle of several tens of seconds, effectively transferring the heat of the high-temperature exhaust gas to the combustion air. (For further detail, see IS-ME-9.)

[Description] Structure explanation, Shape and/or System diagram

1) The structure of the regerative-burner-type aluminum melting furnace is shown in Fig. 1.
2) Fig. 2 is an example of the furnace temperature and the combustion air temperature.

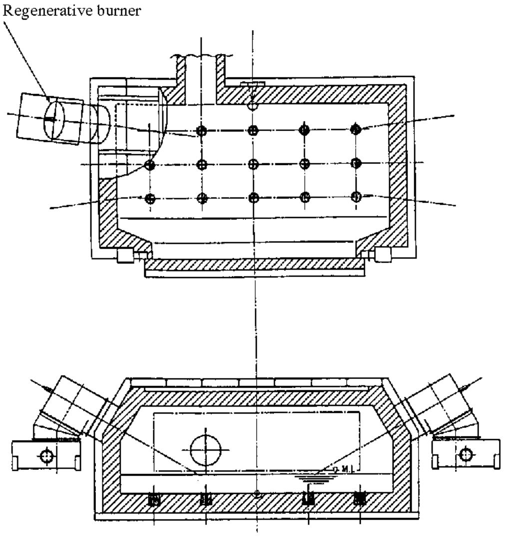


Fig. 1 Regerative-burner-type aluminum melting furnace

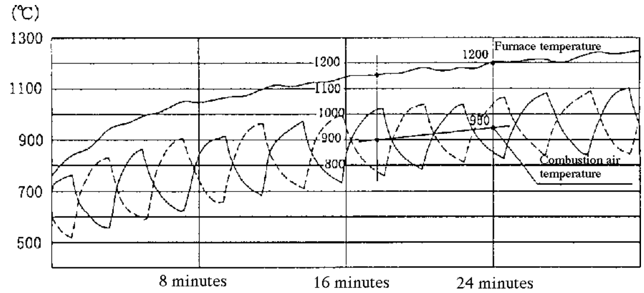


Fig. 2 Furnace temperature and combustion air temperature

Energy saving effect

Table 1 An example of the energy saving effect of regenerative-burner-type aluminum melting furnaces

	Conventional melting furnace	Regenerative melting furnace	Effect
Waste heat recovery method	Recuperator	Regenerative substance (alumina ball)	
Combustion air temperature	200° C on average	800° C on average	
Air ratio	1.2 on average	1.1 on average	
Waste heat recovery ratio	15.1 %	68.2 %	
Specific fuel consumption	682 x 10^3 kcal/t	478 x 10^3 kcal/t	204 x 10^3 kcal/t (30% reduced)
Heat efficiency	40.2 %	57.5 %	
Reduction in crude oil equivalent			1,058.6 kL/year

Operating condition of furnace: 40 t/ch, 4 ch/day, 300 day/year

[Economy] Equipment cost

Investment amount: 70 yen
Improvement effect: 20 - 25 yen/year
Investment payback: 3 - 5 years

Remarks

[Example sites]	[References]	[Inquiry]
Adoption is increasing.	"Industrial Heating (Vol. 35, No. 4, 1997)"	NEDO (JIEC)

NA-OM-1	Energy Conservation Directory	
[Industry Classification] Non-ferrous: Aluminum	Operation method by reduced number of revolutions of circulating fan	[Energy Source] Electricity
[Technology Classification] Operation & Management		[Practical Use] 1982

Outline

A circulating fan of a soaking pit was constantly operated at 100% of the number of revolutions from the start to the end of the operation. Energy saving is realized by the improvement of operation, where the number of revolutions of the circulating fan is reduced.

Principle & Mechanism

Following two points are found by controlling the number of revolutions of the circulating fan.
1) Reducing the number of revolutions of the circulating fan for a few hours after the start of heating does not change the heating time.
2) Reducing the number of revolutions of the circulating fan after the end of soaking gives no effects on material temperature.

[Description]

Structure explanation, Shape and/or System diagram

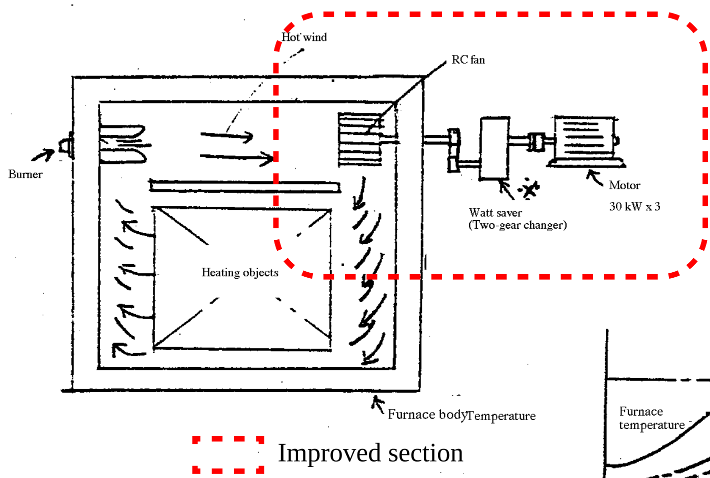
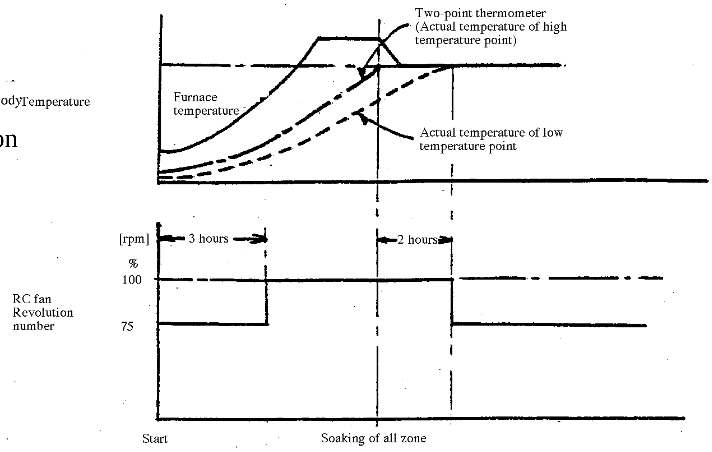


Fig. 1 Structure of Circulating fan



Timing	Before improvement		After improvement	
	RC fan Number of revolution	Electricty	RC fan Number of revolution	Electricity
Start	100%	70 kW	76%	35 kW
Soaking of all zone after two hours	100%	56kW	76%	28 kW
Others	100%	70 ~ 56 kW	100%	Same as before improvement

Fig. 2 Reduction of revolution number

Energy saving effect

From start to 3 hours: 70 kW to 35 kW
After end of soaking: 56 kW to 28 kW

[Economy] Equipment cost

Investment amount: 70 million yen
Improvement effect: 5 million yen/year
Investment payback: 1 - 2 years

Remarks

Reduction of the number of revolutions is also applicable to a heating furnace and softening furnace.
The most suitable methods shall be selected depending on applications (change of a pulley diameter, adoption of a small-capacity and slow-speed motor, adoption of VVVF control, etc.)

[Example sites]	[References]	[Inquiry]
Sumitomo Light Metal Industries, Ltd.	In-house material of Sumitomo Light Metal Industries, Ltd.	NEDO / ECCJ (JIEC)

NA-OM-2

Energy Conservation Directory

[Industry Classification] Non-ferrous: Aluminum	Heat loss improvement of energy saving type electric holding furnace	[Energy Source] Electricity
[Technology Classification] Operation & Management		[Practical Use] 1982

Outline

This is an example of improvement of heat loss at electric holding furnaces used near the casting machine following the melting work of aluminum alloy ingot. Although individual energy consumption is not large, it has a huge effect considering a number electric holding furnaces that have been already installed.

[Description]

Structure explanation, Shape and/or System diagram

[Before improvement] (Fig. 1)

1) As the furnace is made of refractory brick, it features a large heat storage, and has a large thermal conductivity at same time.
2) When bailing out the cast metal in the casting process, thermal diffusion was extremely large as there was no covering over the melting pot.

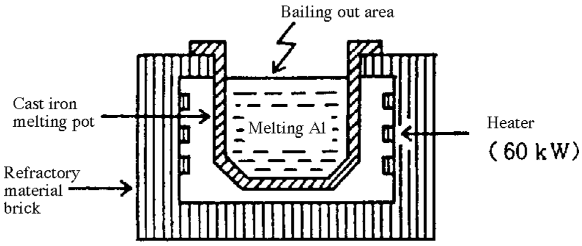


Fig. 1 Structure of conventional type of melting metal holding furnace

[After improvement] (Fig. 2)

1) As the basic material for the furnace body, ceramic lining material has been selected for its high insulation property. Materials of good durability have been attained to stand change of temperature inside the furnace and accommodation of melted metal.
2) The inside of the furnace has been divided into 4 chambers: i.e. chamber for feeding melted metal, heating chamber, bailing-out chamber, and control chamber for managing temperature of melted Al. Each chamber is provided with an independent lid and size of openings are kept to a minimum.
3) The heater has a special structure provided with a special radiant type heater built in the lid. As a result, a large energy saving has become possible by reducing the electrical power of the furnace from previous 60 kW to 12 kW.

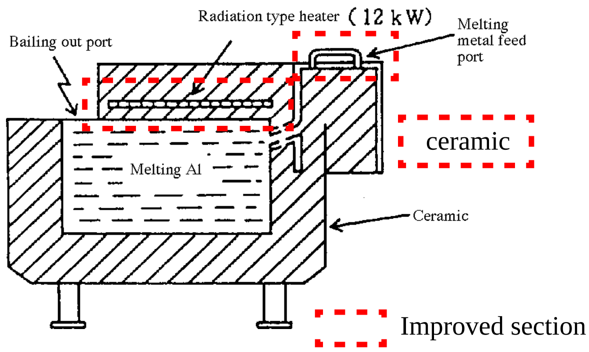


Fig. 2 Construction of the melting metal holding furnace after improvement

Energy saving effect

Table 1 Energy saving of melting pot holding furnace

	Before Improvement	After Improvement	Effect
Electricity consumption amount	156,000 kWh/y	42,000 kWh/y	114,000 kWh/y
Crude oil saving amount rate			28 kL/y

[Economy] Equipment cost

Investment amount: 5 million yen
Improvement effect: 2 million yen/year
Investment payback: 3 years

Remarks

[Example sites]
There are many similar examples executed.

[References]
Collection of Improvement Cases at Excellent Energy Management Plants (1985)

[Inquiry]
NEDO / ECCJ (JIEC)

NA-OM-3	Energy Conservation Directory	

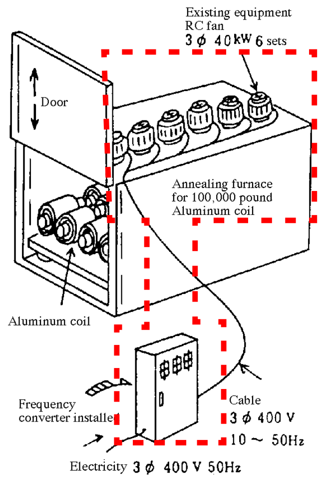
[Industry Classification] Non-ferrous: Aluminum	Improvement of operation of hot air circulation fan for the aluminum annealing furnace	[Energy Source] Electricity
[Technology Classification] Opearation & Management		[Practical Use] around 1980

Outline

Introduced here is an example of remodeling the operation pattern of the hot air circulation fan of an annealing furnace for aluminum coil heat treatment to contribute to energy saving.

Principle & Mechanism

1) As shown in Fig. 1, the coil annealing furnace is a batch type electric furnace.
2) Without replacing the existing motor, a frequency converter has been installed in the control board of the fan motor.



Improved section

[Description]

Structure explanation, Shape and/or System diagram

Before improvement

The furnace fan was under a rated high-speed operation both during a temperature increase and during soaking.

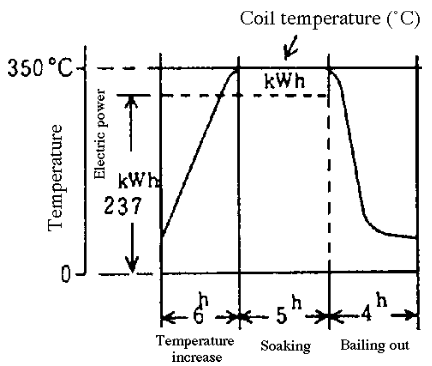


Fig. 2 Characteristic curve of the annealing furnace (Before improvement)

After improvement

It has been reprogrammed so that the fan is operated at rated high-speed during temperature rises until the preset level, and during soaking period, at a reduced rpm of 1/5 of the rating.

Improved section

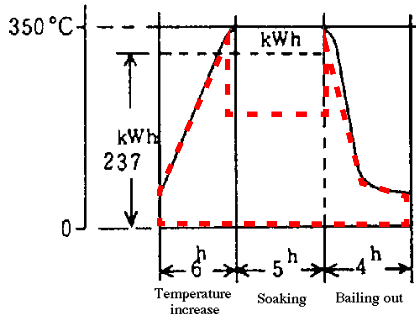


Fig. 3 Characteristic curve of the annealing furnace (After improvement)

Energy saving effect

Table 1 Energy saving effect

	Before improvement	After improvement	Effect
Production volume	29,568 t/y	29,616 t/y	
Electrc power consumption	1,502,904 kWh/y	1,284,400 kWh/y	218,504 kWh/y reduced
Electric power unit requirement	50.8 kWh/t	43.4 kWh/t	7.4 kWh/y reduced
Reduction converted into crude oil			53 kL/y

[Economy] Equipment cost

Investment amount: 6 million yen
Improvement effect: 4 million yen/year
Investment payback: 1.5 years

Remarks

[Example sites]	[References]	[Inquiry]
MItsubishi Aluminum Inc. Fuji Plant	Collection of Improvement Cases at Excellent Energy Management Plants (1984), National Committee for Effective Use of Electricity	NEDO / ECCJ (JIEC)

NC-ME-1

Energy Conservation Directory

[Industry Classification] Non-ferrous: Copper	Efficiency improvement in autogenous furnace in copper smelting process	[Energy Source] Fuel, Electricity
[Technology Classification] Machinery & Equipment		[Practical Use] 1986

Outline

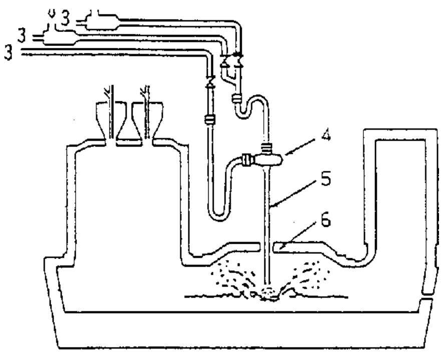
The fuel consumption in the copper smelting process occupies 50 % of thewhole factory. This improvement is an example of the saving energy by the development of the burner suitable for the high slag quality operation and highly oxygen enriched blast operation.

Principle & Mechanism

In the autogenous furnace, the copper concentrate raw material (pulverized sulfide) is blown into the furnace and is burned using the concentrate burners together with the oxygen enriched air for the reaction, the auxiliary fuels such as, heavy oil, and pulverized coal and together with silicate ore. This furnace is the saving energy type which can save the auxiliary fuel, since this method can utilize the maximum oxidation reaction heat when the sulfur and iron in the copper concentrate burn.

[Description] Structure explanation, Shape and/or System diagram

[Measures against prevention of furnace bottom build-up]
The build-up is defined as the precipitation of the magnetite (Fe_3O_4) on the bottom of the autogenous furnace during the high slag quality operation. The build-up reduces the furnace inner volume, and increases the furnace operation troubles. It is necessary to prevent the build-up configuration.



1. Flue dust
2. Pulverized coal
3. Compressed air
4. Mixer
5. Lance pipe
6. Settler ceiling part

Fig.1 The conceptual figure on the settler injection facilities of the autogenous furnace

[Development of the burner suitable for the oxygen highly enriched blast operation]

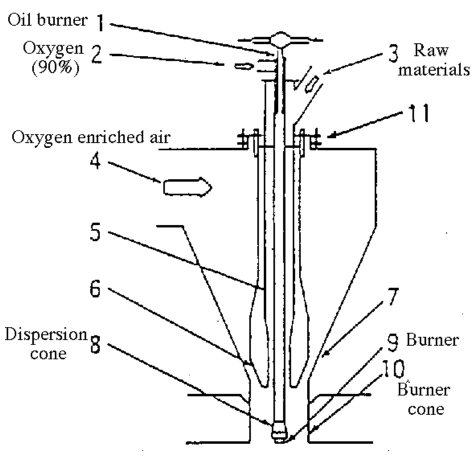


Fig.2 Conceptual figure of the concentrate burner

Table 1 The heat balance of the autogenous furnace

[Input of heat]	(McaL/H)	(%)
Reaction heat	41.049	78.3
Melting heat of the flue dust	-4,543	-8.7
Heat from the charged ore	1,092	2.1
Heat from the reaction air	5,099	9.7
Combustion heat of the heavy oil and pulverized	9,762	18.6
Total	52,459	100.0
[Output of heat]		
Retaining heat of the smelting furnace body	21,880	41.7
Retaining heat of the waste gas	21,614	41.2
Retaining heat of the flue dust	1,895	3.6
Radiation heat	5,400	10.3
Others	1,670	3.2
Total	52,459	

Energy saving effect

The consumption amount of the auxiliary fuel is reduced down to about 50% by the substantial increase of the reaction heat due to the effect of the high slag quality operation

[Economy] Equipment cost

Investment amount: 4 million yen
Improvement effect: 15 million yen/year
Investment payback: 0.3 year

Remarks

[Example sites]	[References]	[Inquiry]
There are many similar examples executed.	Collection of Improvement Cases at Excellent Energy Management Plants (1988) p.81	NEDO / ECCJ (JIEC)

NC-ME-2

Energy Conservation Directory

[Industry Classification] Non-ferrous: Copper	Waste heat recovery of copper smelting shaft furnace using heat pipes	[Energy Source] Fuel
[Technology Classification] Machinery & Equipment		[Practical Use] 1985

Outline

This improvement is an example of the waste heat recovery by introducing rotary type heat pipe heat exchanger (abbreviated to R.H.P after this) in order to increase the heat efficiency of the shaft furnace in the copper wire rough drawing production process.

Principle & Mechanism

[The structure of the rotary type heat pipe heat exchanger (R.H.P)] (Refer to Fig.1)

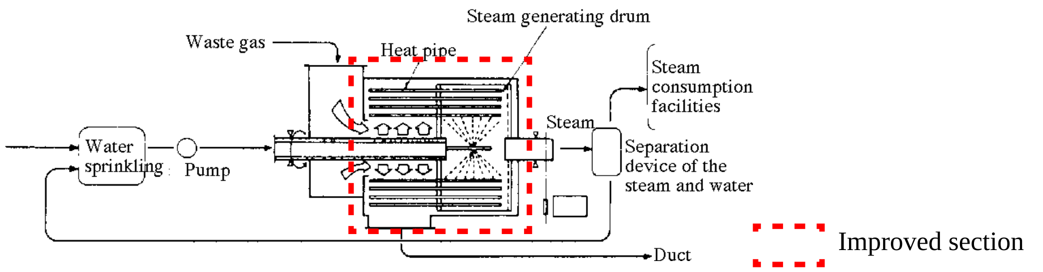


Fig.1 Outline diagram of the R.H.P and system flow

[Description]

Structure explanation, Shape and/or System diagram

1) The heat efficiency of the furnace was about 60 %, the loss of the furnace top waste gas was about 14%, and the average temperature of the waste gas was 220 ˚C before the improvement .
2) Fig.2 shows schematic illustration of the shaft furnace, and Fig.3 shows the flow of the waste heat recovery.
3) The amount of the energy recovery was about 370,000 kcal/h, and the heat efficiency of the shaft furnace was improved about 7.5% up to 67.5%

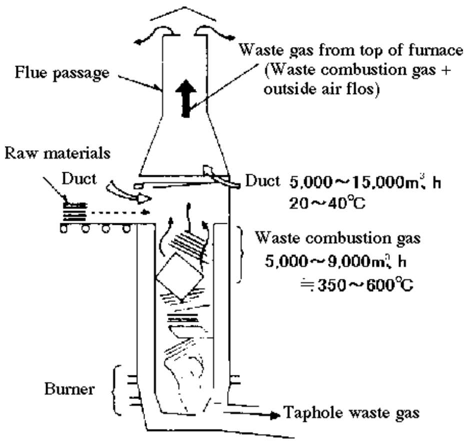


Fig. 2 Schematic illustration of separation device of the steam shaft furnace

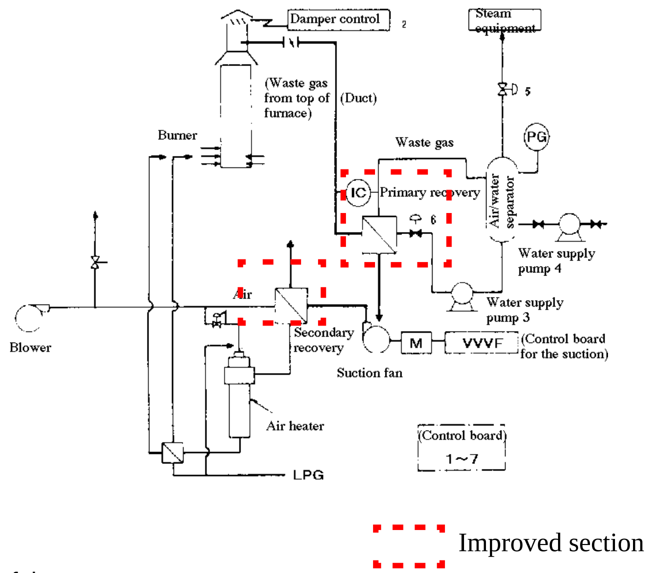


Fig.3 The flow of the waste heat recovery

Energy saving effect

Table 1 Energy saving effects by the waste heat recovery of a shaft furnace (Operation time : 7000h/year)

	Before improvement	After improvement	Effect
Heat efficiency of the shaft furnace	60%	67.5%	7.5 improvement
Amount of waste heat recovery		570,000 kcal/h	570,000 kcal/h
Reduction amount of crude oil equivalent			431 kL/year

[Economy] Equipment cost

Investment amount: 50 million yen
Improvement effect: 20 million yen/year
Investment payback: 2.5 years

Remarks

[Example sites]	[References]	[Inquiry]
The Furukawa Electric Co. Ltd. Mie Factory	Energy Saving Journal (Vol. 39, No. 7, 1987) p.37	NEDO / ECCJ (JIEC)

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Energy Conservation Directory

[Industry Classification]	Energy saving in copper electrolysis process	[Energy Source]
Non-ferrous: Copper		Electricity, Fuel (Steam)
[Technology Classification]		[Practical Use]
Operation & Management		1993

Outline

Anodes made from the crude copper (99.3%Cu) is refined to the electrolytic copper (99.3% Cu) in the copper electrolysis process. An example of the electric energy saving by reducing the resistance of the electrolytic solution in the copper electrolysis process and of the reduction of the steam consumption by preventing the radiation of the heat from the electrolysis tank.

Principle & Mechanism

Energy consumption structure in the electrolysis tank]
The electric power used in the copper electrolysis process (Fig.1) is mainly composed of the energy consumed in the electrolysis, and the energy consumed as the Joule's heat by the resistance of the electrolytic solution. This Joule's heat occupies about 60% of the energy used in the electrolysis tank.
The steam is consumed so as to maintain the temperature of the electrolytic solution at 62 ˚C.

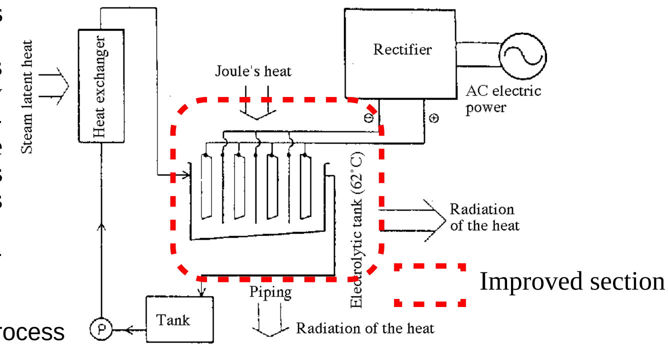

Fig.1 Energy flow of copper electrolysis process

[Description] Structure explanation, Shape and/or System diagram

[Measures to reduce the electric power]

1) In order to increase the anode weight, there are two methods such as the increase of the width and the thickness of anodes. Since the distances between the position of the anode and cathode in the electrolysis tank are decided, the distance can be reduced by increasing the thickness of the anodes. As a result, the reduction of the electric power consumption can be obtained to such an extent thatthe electric current flowing distance is shortened, and the electric voltage generated by the electric resistance of the electrolytic solution drops.
2)The relation between the electric voltage drops and distances between anode and cathode

Electric voltage drops (V) = {Distance reduction between anode and cathode (0.1cm)} / {Electric conductivity of electrolytic solution (0.7S/cm)} x {electric current density (0.026A/cm^2) }= 0.004 V

According to the formula above, electric voltage drops of 4 mV correspond to the reduction of the distance of 0.1 cm. Therefore, the electric voltage drops correspond to 1.5%, since the electric voltage per a tank is 270 mV.

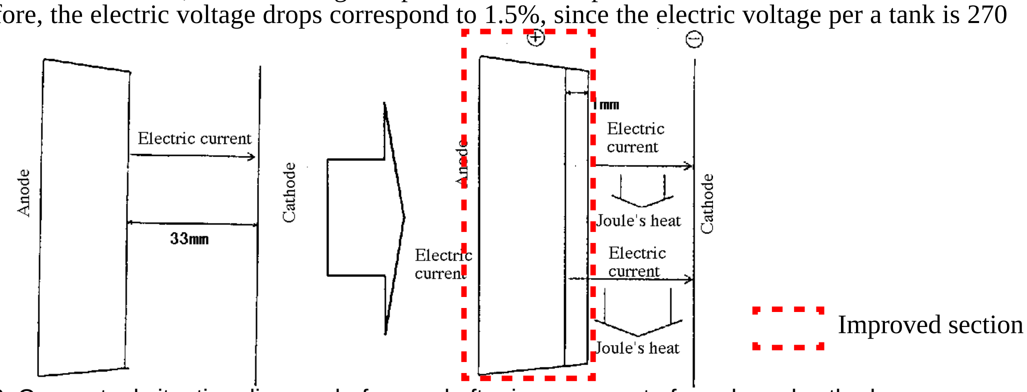

Fig. 2 Conceptual situation diagram before and after improvement of anode and cathode

Energy saving effect

Table 1 Energy saving effects of improvement on copper electrolysis tank (Production amount: 200,400 t/y base)

	Before improvement	After improvement	Effect
Unit cost for electric power used in electrolysis	264 kWh/t	258 kWh/t	6 kWh/t recuction
Rreduction amount of steam	19,056 t/y	9,660 t/y	9,396 t/y reduction
Reduction amount of crude oil equivalent			

[Economy] Equipment cost

Investment amount: none
Improvement effect: 31 million yen/year
Investment payback: years

Remarks

[Example sites]	[References]	[Inquiry]
Nikko Kinzoku Co. Ltd, Saganoseki Smelting Factory	"Collection of Energy Conservation Cases 1995," p.999	NEDO / ECCJ (JIEC)